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INTERIM REPORT ON THE INFLUENCE OF HUCKLEBERRY PRODUCTION IN WESTERN MONTANA

AUGMENTING HUCKLEBERRY PRODUCTION for the IMPROVEMENT of GRIZZLY BEAR HABITAT

by
Nellie M. Stark and Stephen P. Baker

FINAL REPORT forCOOPERATIVE RESEARCH AGREEMENT
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FS CONTACT: L. Jack Lyon (ADOR)
Cooperator Contact: Nellie M. Stark (PI)

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TO

U.S. FOREST SERVICE, WILDLIFE RESEARCH UNIT, JACK LYON PROJECT LEADER, MISSOULA, MT 59812

Nellie M. Stark and Stephen P. Baker

SCHOOL OF FORESTRY, UNIVERSITY OF MONTANA, MISSOULA, MT 59812

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INTRODUCTION

Two studies were established on the effects of herbicides on fruit production in Vaccinium globulare. The first was funded by the Montana Science and Technology Alliance and involved twenty plots over five locations where one of the treatments was Brush-B-Gone and the others were pruning competing brush, complete removal of brush mechanically, and a control. Brush - B - Gone was applied as instructed on the container by painting the cut stems with the concentrate. These studies were in their second growing season in 1988. The second was funded by the U.S. Forest Service and used four concentrations of hexazinone (Velpar) on 4 plots sprayed in the spring and 8 others in the fall. A total of 48 plots were established at 12 locations within huckleberry producing environments. Those at Chicago Peak (Hex 1-4) were sprayed in the spring before bud emergence at 1/2, 1 and 2 lb/acre application rates. The plots at Miller Creek (Hex 5,6), Baker Road (Hex 7,8), Orr Mt. (Hex 9), Government Mt (Hex 10) and Edith Peak (Hex 11,12) were sprayed after the plants were dormant in the fall using 1,2,3 lbs hexazinone/acre and a control for each location. The hexazinone tests were in their first growing season in 1988.

The results of these two studies are summarized here briefly because they both have bearing on the prospects of improving huckleberry production for grizzly bear habitat. All data (berry numbers and weight, ripe and green, including overripe, but excluding mummy berries) were analyzed by ANOVA and the Duncan

Multiple Range Test with a significance level of p= <.05. Projected dry weights and p values appear in Table 3. Refer to the species lists for each site and herbicide treatment, except for the Brush - B - Gone treatments which do not have complete species lists.

RESULTS

BRUSH - B - GONE STUDIES

The following sites were treated with Brush -B - Gone or had brush pruning (to increase light to the plants) or brush removal (to improve water and nutrient availability, and light) to enhance fruit production:

Miller Creek - This area is at low elevation and the plants failed to produce a fruit crop in the droughty summer of 1988. Early frost damage to the flowers is thought to be the main cause of fruit failure. Summer drought was severe at this site.

Orr Mountain - This area is at mid-elevation and had an exceptionally good fruit crop in 1988. Tables 1 and 3 show that the cut plus Brush-B-Gone treatment had larger numbers of green fruit/m2 in mid-August than the control, pruning treatment and the treatment where brush was removed by cutting. These results suggest that for that site, the herbicide augmented green fruit production above what would be expected if the competing brush had been cut alone. It is possible that opening the stand to allow more light through brush removal increased the time period over which fruit were ripening, ie. period of pollination, resulting in a larger percentage of green fruit relative to ripe

fruit during August. A long period of fruit ripening is a recognized reproductive strategy for this species. Ripe fruit numbers and weights were not significantly different by treatment.

Government Mountain - This is a high elevation site with little brush but considerable Xerophyllum tenax and tree competition. The results showed greater numbers of green fruit/ m2 for the control plots, compared to the plot where the brush was pruned to allow full sun light on the huckleberry plants, and to the cut plus herbicide treatment (Table 1 ,3). The treatment where the brush was cut had greater numbers of green fruit/m2 than the cut plus herbicide treatment. Water is probably not limiting to fruit production on this site so that the removal of brush by herbicide application or even through cutting had no dramatic effect on green fruit production. No significant differences among treatments occurred for the ripe fruit. The control plot here was extremely dense, with retarded fruit development because of cooler temperatures during the summer from the competing plants. The result was that at the point in time when sampling occurred, the control plots had less advanced fruit development, not significantly more green fruit.

Hypo Ridge - This location is an open sunny area with tall Alnus sinuata as the main competition for the huckleberry plants. The removal of the Alnus appears to have been a shock to the plants, with little improvement in fruit production in the first and second years after treatment. No significant differences in

fruit production by treatment were found for this mid-elevation location.

Hungry Horse (Above Beaufait Fire Study) - This location is at upper - mid elevation and normally has some water stress during summer. The brush is varied in size and exerts a strong influence on fruit production, with the large number of small shrubs and young conifers present. Results showed that the number and weight of ripe fruit/m2 present in the plots where the brush was cut were significantly greater than the number and weight of ripe fruit/m2 in the control, prune and cut plus Brush-B-Gone treatments (Table 1,3). For green fruit, the number /m2 in the cut plot was significantly higher than for the control and for the cut plus herbicide plots. The control appeared to be too heavily shaded for much fruit production. The prune plot had significantly more green fruit/m2 than the cut plus herbicide plot.

Physically cutting and removing the brush appeared to have the most influence on green and ripe fruit production on this site. The numbers of fruit produced at this location was unusually large, making a good separation of treatment effects possible (Table 1 ,3). Herbicide treatment was by painting Brush - B - Gone on the cut stems. Much of the competing vegetation here was of small stem diameter or non-sprouting trees, making it difficult to treat every stem that was cut. Thus, herbicide treatment did not significantly improve fruit production. The control on this site is extremely dense so that control fruit

production was severely limited by light. Almost any opening up of the lower brush canopy benefitted fruit production, including pruning in one instance. The open areas had more green fruit well into August than the denser control. From these preliminary results, herbicide application is less likely to be effective on sites with conifers that do not resprout and sites with dense, small-stemmed brush. All other sites had larger stemmed brush plants, except at Edith Peak.

Edith Peak - Two plots were established in the fall with direct application of 2,4-D and Roundup to the foliage of Xeorphyllum tenax which is a major compenent of some stands of huckleberries after thinning. These treatments produced significant reduction in the amount of bear grass foliage, but to date, no fruit crop has occurred that will allow the evaluation of removal of the competing Xerophyllum.

Results for total fruit production, using projected fruit weights for the green fruit, have yet to be processed for this study. Also, data are available on the amount of living Vaccinium stems/m2 of each sample plot so that production per stem is yet to be analyzed for significant differences. Numbers of stems per plot varied considerably.

The greatest dry weights of fruit/m2 came from the cut treatment at Hungry Horse. Government Mountain and Orr Mt. also had good fruit production (15 to 26 g dry fruit/m2, Table 1). These data are some of the best fruit production data so far available for this species, but we need to be able to factor in

plant numbers and size, which is p resently being done.

HEXAZINONE STUDIES

The twelve sites that received hexazinone were probably poorly suited to respond to treatment during the first summer after treatment, but results do indicate some significant responses ($p<.05$). Flower buds were set in the autumn of 1987, before the treatments were applied.

Chicago Peak, Hex 1 - This site is at mid-elevation and has dense brush competition. Fruit production in 1988 was extremely spotty on this plot, with some areas lacking fruit and others with large, abundant fruit, creating extremely high standard deviation in the results. Some minor damage to the huckleberry plants was noted with the 2 lb/acre treatment. The only significant result was the greater weight of ripe fruit/m2 in the control plot, compared to the 1 lb/acre treatment (Tables 2,3). There is no good explanation for this difference in expected results.

Chicago Peak, Hex 2 - This site has an east aspect at mid-elevation and most of the brush species are tall and offer only partial shade to the huckleberry plants. Results for ripe fruit show that the control and 1/2 lb/acre treatments had larger numbers of ripe fruit/m2 than the 2 lb/acre treatment (Table 2,3). The same relationship held true for the 1/2 lb/acre treatment and the weight of ripe fruit/m2, compared to the 2lb/acre application. The numbers of green fruit were greater in

the control, 1/2 and 1 lb/acre treatments than in the 2 lb/acre treatment. This suggests that the 2lb/acre treatment actually had some detrimental effects on fruit production, some influence beyond simple removal of competition. This is a moist site with available water most of the season. A few of the plants were injured in the 2lb/acre treatments. Results in the summer of 1989, if fruit are produced, will be extremely valuable in discerning what effect the herbicide has had on fruit production. When hexazinone has been used in the east on V. angustifolium, it often reduced production for a short time before there was a significant increase in fruit.

Chicago Peak, Hex 3 - This is a semi-droughty south slope with low brush that does not directly shade many of the plants. The main competition is through the root systems for water and nutrients. For number of ripe fruit/m2, the 1/2 lb/acre treatment was superior to the 1 and 2 lb/acre treatments (Table 2,3). The weight of ripe fruit/m2 was also superior in the 1/2 lb/acre treatment, compared to the 2lb treatment. The control had significantly more green fruit/m2 than the 1/2 or 2 lb/acre plots. These results suggest that where water is likely to be severely limiting, the lighter 1/2 lb/acre treatment can improve production, but not necessarily above that of the control. A second year's data will be extremely valuable in this plot also. At this point, it is thought that the low brush that does not shade the huckleberries may be significantly damaged by 1/2 lb/acres hexazinone, while higher application rates did nothing

to stimulate the production of fruit on the huckleberry plants themselves nor to control the brush species. Further information on the peculiarities of this site are needed.

Chicago Peak, Hex 4 - No significant differences in fruit production were found on this site, which is mid-elevation, droughty, with open brush and little direct shade on the huckleberry plants. The site did receive spring frost damage which appears to have washed out any treatment effects. This site is considerably more droughty than Hex 3.

Miller Creek, Hex 5 and 6 - This is a low elevation site which had a light fruit crop during 1988, inadequate for analysis.

Baker Road, Hex 7 - The 3lb/acre application rate had significantly greater amounts of fruit/m2 than either the control (green) or 1lb treatment (ripe, Table 2,3). No other significant differences were found. This location is droughty and has small plants that have not had a good crop of fruit in the 18 years that the author has observed them, until 1988. Since hexazinone acts through the soil, it may require a higher application rate on an extremely droughty site to get the chemical into the root zone in effective levels. Data from Hex 4, if available in 1989, will help to confirm or refute this suspicion.

Baker Road, Hex 8 - As with Hex 7, this companion plot had significantly greater number of ripe fruit/m2 and weight of ripe fruit/m2 (except for the 1lb treatment) in the 3lb/acre treatment, compared to the control, 1lb and 2lb/acre application

rates (Table 2,3). The 3lb/acre plots also had significantly more green fruit than the control, 1 or 2 lb/acre treatments. Results in Hex 8 partly confirm those in Hex 7 and strengthen the hypothesis that a higher concentration of hexazinone is needed to influence fruit production in the more droughty plots.

Orr Mountain, Hex 9 - This site is a moist, high production site where good fruit production is likely to occur nearly every year. It is the opposite extreme from Hex 7 and 8 in terms of available water and plant size, but both areas had high fruit production in 1988. The brush species are diverse and densely spaced and competition is severe, but light is perceived to be the major limiting factor. The control and 1lb/acre treatments had significantly more ripe fruit/m2 than the 3lb/acre application. When weight of ripe fruit was considered, the 1 lb/acre treatment had more ripe fruit/m2 than the 2 or 3 lb/acre treatments (Tables2,3). This suggests that the hypothesis developed for Hex 7 and 8 might hold true. Where there is plenty of water, lower concentrations of hexazinone were effective in stimulating fruit production and higher concentrations were detrimental. The amount of water present in the system should relate to how much and how fast the hexazinone permeates the soil. It is quite possible that this trend would reverse with more time and leaching. The crop from year 2 should tell someting about the longevity of the treatments.

Government Mountain, Hex 10 - This is a high elevation, cold site where much of the brush is dense and where there is

considerable competition from conifers. For numbers and weight of ripe fruit/m2, all treatments had higher fruit production than the control (except 3lb/ac was not greater than the control for weight of ripe fruit, Tables 2,3). The numbers of green fruit were greater in the 3 lb/ acre treatment than the control and 1 lb, but not than the 2 lb (reason unknown). At this location, water is usually abundant, but sunlight may be limiting. The control, like the BBG site at Hungry Horse, was heavily shaded after treatment resulting in low fruit counts. The herbicide had some effect in improving production, although major killing of the competing brush was not observed. What was evident was that plants that were in the sun matured fruit earlier and that more flowers appeared to produce fruit in the open areas after spraying. There are suspicions of direct stimulation of fruit production here, but no clear-cut pattern has yet emerged.

Edith Peak, Hex 11 and 12 - These plots are in an open sunny high elevation meadow with mostly Xerophyllum tenax competition. The heavy frost in May in this area destroyed most of the flowers so that very little fruit was available for analysis. Summer drought resulted in small fruit as well.

The highest dry weights of fruit production (35.5g/m2) occurred at Hex 2 with the 1/2 lb/acre treatment. Good dry weights of fruit were also achieved at Hex 7 and 8 with the 3 lb/acre treatment (Table 2).

These data have yet to be processed for mean number of fruit per stem and total projected fruit production. These results

will be made available as soon as possible.

If any conclusions can be made from the results to date, it is that large numbers of plots would have to be harvested to avoid the extremely high standard deviations that occur in fruit production (Tables 1, 2). We will try to estimate how large the samples would have to be to accommodate natural population variation. We conclude that a second year's data is vital to completing the picture of what has happened as a result of the treatments. At present, we are contemplating repeating the treatments on at least the BBG plots and possibly on the hexazinone plots as well.

One other observation to date is that the net effect of the herbicides on production appears to depend on specific site conditions such as the species, height and age of the brush, the amount of sun and aspect of the site and the degree to which water is limiting to the plants. More attention will be paid to these aspects of the study in 1989, although the study was designed to provide a wide latitude in site conditions against which to judge the effects of herbicides.

SPECIES SUSCEPTIBILITY TO THE HERBICIDES

The report submitted in the fall of 1988 summarized as far as possible the information available on individual species sensitivity to hexazinone. No further data are available at this time on this aspect of the study. Much of the work in 1989 will be focused on determining which species appear to have been most

severely damaged by both herbicides. Observations of the conditions of the huckleberries and associated brush species in the field will be made before a decision to reapply the treatments to the same plots can be reached.

RESULTS OF MULTIPLE RANGE TESTS WHEN CORRECTED FOR DRY WEIGHT OF FRUIT PER STEM -HEXAZINONE PLOTS

The results reported earlier were corrected for the projected weight of dry fruit per stem using data taken in the field. The results appear below and in Table 4.

Plot 1 - In this moist site plot, the control showed greater fruit weight per stem than either the 1 or 2 lb/ acre treatments. There was no significant difference between fruit dry weight /stem in the control or 1/2 lb/acre plots. The hexazinone treatment appeared to be detrimental on this moist site.

Plot 2 - This site was on a more easterly aspect than plot 1. The control, 1/2 lb, and 1 lb/acre treatments all showed significantly greater dry weight of fruit/stem than the 2 lb/acre treatment. The 1/2 lb/acre treatment had significantly greater dry weight of fruit/stem than the control. For this plot, the 2lb/acre treatment appeared to be detrimental, with the lightest treatment, 1/2 lb/acre, the most beneficial. This is in keeping with the hypothesis that wetter sites appear to need less hexazinone to affect fruit production. Heavy hexazinone treatment in the spring on this plot may have reduced fruit production.

Plot 3 - This plot was on approximately the same aspect as

plot 2. Results showed greater dry weight of fruit produced /stem in the control and 1/2 lb/acre treatments. As with plot 2, heavy application rates appear to have reduced fruit production during the first season.

Plot 4 - This dry site plot showed significantly more fruit production at 2 lbs/acre application rate, compared to the 1/2 lb/acre treatment. This again suggests that bear habitat would be improved by heavier application of hexazinone on the drier sites.

Plots 5, 6 and 7 - No treatments showed any significant differences when campared in these plots on a dry weight/stem basis. Plots 5 and 6 had almost no fruit at all. Fruit production per stem in plot 7 was quite high.

Plot 8 - Plot 8 was also quite dry and hot. Here the 3lb/acre treatment produced greater fruit dry weight/stem than in the control or 2 lb plots. There is definite evidence here of possible improvement of grizzly bear habitat on dry sites by use of the heavier hexazinone treatments. It is puzzling that plot 7 did not show the same results as plot 8 since they were quite close spatially. Plot 8 had a large number of plants that bear red fruit and are known to be more drought resistant than the bluer berried plants. There is a possibility of subspecies differences in response to hexazinone here, even though no subspecies, as such, have been recognized by the taxonomists.

Plot 9 - The Orr Mt plot had significantly greater weights of fruit/stem when treated with 1lb hexazinone/acre as opposed to

3 lbs/acre treatments. This is a very moist site with indications that the heavier treatments do not favor improvement of fruit production for grizzly bears. None of the treatments produced significantly more fruit than the controls, suggesting that the extremely high production on this plot may be at or close to optimum. Thus, some areas that are moist may not be improved in terms of fruit production for bears in extremely good years. What is needed is more data from other years that are not as ideal to determine if these sites will respond to herbicide treatment differently under some water stress.

Plot 10 - This high elevation plot showed significantly greater dry weightd of fruit/stem for both the 1 and 2 lb/acre treatments relative to the control. Here we have clear evidence of the stimulation of fruit production on a per stem basis on a site with a short growing season and frequent summer water stress. This site appeared to respond quite well to hexazinone in the 1 and 2 lb/acre applications.

Plots 11 and 12 - No fruit were available to evaluate treatment effects on this high elevation site.

These results reported as dry grams of fruit / stem are considered to be the best estimates of the effect of hexazinone in improving fruit production for bears. The data from only one year suggest that the best results are likely to occur on the drier sites where removal of brush competition for water may benefit the actual number of fruit that reach maturity. Some wetter sites appear to respond to lower application rates, or

show no response at all to the herbicide. We suggest that careful monitoring of soil moisture by gravimetric means during this summer will be essential to supplying information needed to determine which sites are most amenable to improvement of grizzly bear habitat.

PREDICTION OF BIOMASS USING MEASURED FIELD VARIABLES

The heights of the stems in this study were quite variable, from 20 cm to 150 cm. Thus, dry weight of fruit per stem does not always produce data that can be fairly compared, because of differences in biomass per stem. For this reason, we ran a small side study to examine the possibility of predicting stem biomass from simple field measurements. The most easily obtained prediction of biomass used the equation:

Stem Biomass = 88.21041 + (0.01035 basal stem volume) R2 = 0.899

The basal stem volume was obtained by measuring the stem diameter at ground level and at the base of the crown. These measurements were not taken for plants in the 12 hexazinone plots and so, the data cannot be corrected for biomass. The appropriate measurements will be taken during the coming summer when collecting fruit so that production on the basis of living stem biomass (projected) can be used.

A second equation used more measured field variables but gave a better R2:

Stem Biomass = 62.34626 + (0.00770 basal stem volume) + (0.00046 crown volume) R2 = 0.93

In the latter equation the crown volume is estimated by its depth

and width as a half-sphere. The added time needed to obtain the necessary measurements for this prediction may not be justified, but it will be possible to relate productivity of fruit to actual above-ground biomass in the future. We feel that this is an essential step in obtaining better measurements of fruit production using herbicides to improve grizzly bear habitat.

Table 4. Results of multiple range tests of the effect of hexazinone application rates on the dry weight of fruit/stem.

Plot No.	Treatments (lb/ac)	P
1	Control > 1	.026
	Control > 2	.033
2	Control > 2	.011
	1/2 lb/ac > 2	.000
	1 lb/ac > 2	.001
	1/2 lb/ac > control	.019
3	Control > 1	.030
	1/2 lb/ac > 1	.036
4	2 lb/ac > 1/2	.038
5,6,7	No differences	
8	3 lb/ac > control	.012
	3 lb/ac > 2 lb/ac	.046
9	1 lb/ac > 3 lb/ac	.040
10	1 lb/ac > control	.025
	2 lb/ac > control	.003
	2 lb/ac > 3	.033

Table 1. Summary of mean and standard deviations of ripe and green fruit weights and numbers from the Brush-B-Gone Study.

Location	Tr.	No. Ripe $\bar{X}$	No. Ripe SD	Wt. Ripe $\bar{X}$	Wt. Ripe SD	No. Green $\bar{X}$	No. Green SD	Projected Dry Wt., g/m^2
Orr Mt.	Con.	176	56	56	16	63	55	16.98
	Prune	236	106	89	33	27	18	20.85
	Cut	208	147	76	60	33	39	18.74
	Cut + H	136	92	56	39	171	124	26.85
Goverment Mt.	Con.	110	44	41	19	80	27	15.60
	Prune	152	84	68	37	37	24	18.43
	Cut	172	117	63	44	56	29	17.95
	Cut + H	177	60	90	39	18	9	20.95
Hungry Horse	Con.	105	43	36	18	3.6	3.7	7.85
	Prune	185	112	74	45	20	9	17.06
	Cut	364	104	200	78	16	8	45.56
	Cut + H	47	35	22	17	3	4	4.96
Miller Ck.	(none)							
Hypo	Con.	51	41	24	25	12	19	7.31
	Cut B.	82	156	29	59	23	23	7.89
	Cut All	0.5	1.2	.16	.38	5.3	6.5	1.15

* Con. = control, Prune = open to sun, Cut = cut all brush, Cut + H = Cut brush and apply Brush-B-Gone.

Table 2. Summary of mean and standard deviation for weight and number of ripe and green *Vaccinium globulare* fruits one year after treatment, n = 5.

Location		No. Ripe X	No. Ripe SD	Wt. Ripe X	Wt. Ripe SD	No. Green X	No. Green SD	Projected Dry Wt, g/m^2 X
Spring	Tr.							
Chicago Pk.								
Hex 1	C	136	113	58*	49	180	74	20.12
	1/2	82	36	37	17	50	33	12.72
	1	38	34	13*	11	146	93	13.62
	2	57	73	20	28	126	137	14.32
Hex 2	C	148*	42	58	15	87*	43	19.38
	1/2	203*	168	98	85	132*	62	35.63
	1	116	41	57	21	76*	43	20.58
	2	8*	7	3	2	12*	10	1.56
Hex 3	C	114	79	41	30	180	44	22.82
	1/2	201*	88	75	40	81	62	23.15
	1	108*	94	29	25	85	75	11.37
	2	55*	34	22	16	111	73	13.97
Hex 4	C	53	58	21	23	109	60	13.47
	1/2	32	30	9	7	75	22	6.88
	1	31	60	11	21	106	65	10.78
	2	52	35	22	17	113	77	15.40
Fall								
Miller Ck.								
Hex 5	C	0	0	0	0	0	0	
	1	0	0	0	0	0	0	
	2	0	0	0	0	0	0	
	3	0	0	0	0	0	0	
Hex 6	C	1.0	0.7	.24	.30	0	0	0.05
	1	0.6	1.3	.06	.13	.8	1.3	0.06
	2	12.6	13.9	3.4	4.0	11.2	9.2	1.39
	3	2.6	4.2	0.8	1.5	1.0	1.4	0.17
Baker R.								
Hex 7	C	193*	35	47	6	36	34	11.64
	1	163	100	55	20	97	41	19.31
	2	210	97	56	17	85	56	17.07
	3	285*	85	68	23	155	72	23.48
Hex 8	C	192	35	47	6	36	35	11.64
	1	277	62	67	18	96	51	19.48
	2	213	71	49	12	91	51	15.14
	3	468	142	89	39	271	213	29.52

Table 2. (Continued)

Location		No. Ripe		Wt. Ripe		No. Green		Projected Dry Wt, g/m^2
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$
Fall	Tr.							
Hex 9	C	132*	64	45	23	56	61	13.30
	1	146*	99	59	40*	47	22	16.73
	2	86	61	23	16*	54	28	8.34
	3	26*	21	11	9*	22	7	4.51
Hex 10	C	5*	7	2*	2	52*	39	3.46
	1	173*	104	66*	51	75*	17	20.13
	2	126*	49	40*	15	127	12	17.17
	3	96*	42	33	13	144*	76	17.44
Hex 11	C	3.2	1.8	.2	.1	4.0	4.8	0.08
	1	0.8	1.1	.06	.1	5.4	1.8	0.03
	2	4.0	3.0	.14	.14	12.8	9.0	0.12
	3	4.2	3.0	.16	.11	14.4	15.2	0.15
Hex 12	C	1.2	1.3	.10	.12	4.0	4.8	0.12
	1	0.4	0.9	.05	.12	5.2	1.9	0.18
	2	1.6	1.8	.09	.12	14.0	13.3	0.20
	3	3.2	2.6	.18	.16	13.4	12.5	0.21

Table 3. Summary of significant differences in fruit production and p values for the Brush-B-Gone and hexazinone study plots.

Brush-B-Gone

Location	Treatment	Stage of Fruit	p
Orr Mt.	Cut + H > control	no. green fruit/m^2	0.030
	Cut + H > prune	no. green fruit/m^2	0.009
	Cut + H > cut	no. green fruit/m^2	0.010
Gov. Mt.	Control > prune	no. green fruit/m^2	0.013
	Control > Cut + H	no. green fruit/m^2	0.001
	Cut > Cut + H	no. green fruit/m^2	0.028
Hungry H.	Cut > control	no. ripe fruit/m^2	0.000
	Cut > prune	no. ripe fruit/m^2	0.003
	Cut > Cut + H	no. ripe fruit/m^2	0.000
	Cut > Control	wt. ripe fruit/m^2	0.000
	Cut > Prune	wt. ripe fruit/m^2	0.001
	Cut > Cut + H	wt. ripe fruit/m^2	0.000
	Prune > control	no. green fruit/m^2	0.002
	Cut > control	no. green fruit/m^2	0.008
	Prune > cut + H	no. green fruit/m^2	0.002
	Cut > Cut + H	no. green fruit/m^2	0.008

Hexazinone

Hex 1	Control > 1 lb/ac	wt. ripe fruit/m^2	0.045
Hex 2	Control > 2 lb/ac	no. ripe fruit/m^2	0.030
	1/2 lb/ac > 2 lb/ac	no. ripe fruit/m^2	0.005
	1/2 lb/ac > 2 lb/ac	wt. ripe fruit/m^2	0.006
	Control > 2 lb/ac	no. green fruit/m^2	0.018
	1 lb/ac > 2 lb/ac	no. green fruit/m^2	0.034
	1/2 lb/ac > 2 lb/ac	no. green fruit/m^2	0.001
Hex 3	1/2 lb/ac > 2 lb/ac	no. ripe fruit/m^2	0.013
	1/2 lb/ac > 1 lb/ac	wt. ripe fruit/m^2	0.028
	1/2 lb/ac > 2 lb/ac	wt. ripe fruit/m^2	0.015
	C > 1/2 lb/ac	no. green fruit/m^2	0.038
	C > 1 lb/ac	no. green fruit/m^2	0.041
Hex 4	(no significant differences)		
Hex 5	No fruit		
Hex 6	No fruit		
Hex 7	3 lbs/ac > 1 lb/ac	no. ripe fruit/m^2	0.037
	3 lbs/ac > 1 lb/ac	no. green fruit/m^2	0.004
Hex 8	3 lbs/ac > control	no. ripe fruit/m^2	0.000
	3 lbs/ac > 1 lb/ac	no. ripe fruit/m^2	0.003
	3 lbs/ac > 2 lb/ac	no. ripe fruit/m^2	0.000
	3 lbs/ac > control	wt. ripe fruit/m^2	0.015
	3 lbs/ac > 2 lb/ac	wt. ripe fruit/m^2	0.018
	3 lb/ac > control	no. green fruit/m^2	0.007
	3 lb/ac >1 lb/ac	no. green fruit/m^2	0.027
	3 lb/ac > 2 lb/ac	no. green fruit/m^2	0.030

Table 3. (Continued)

Location	Treatment	Stage of Fruit	p
Hex 9	C > 3 lb/ac	no. ripe fruit/m^2	0.030
	1 lb/ac > 3 lb/ac	no. ripe fruit/m^2	0.019
	1 lb/ac > 2 lb/ac	no. ripe fruit/m^2	0.049
	1 lb/ac > 3 lb/ac	wt. ripe fruit/m^2	0.012
Hex 10	1 lb/ac > C	no. ripe fruit/m^2	0.001
	2 lb/ac > C	no. ripe fruit/m^2	0.009
	3 lb/ac > C	no. ripe fruit/m^2	0.003
	1 lb/ac > C	wt. ripe fruit/m^2	0.003
	2 lb/ac > C	wt. ripe fruit/m^2	0.046
	3 lb/ac > C	no. green fruit/m^2	0.007
	3 lb/ac > 1 lb/ac	no. green fruit/m^2	0.031
Hex 11	(No significant difference, too few fruit)		
Hex 12	(No significant difference, too few fruit)		

Summary of Species Composition of
Hexazionone Treated Plots - 1987 - Year 1

Spring Tr. Species	Plot No. Hypo 1				Hypo 2				Hypo 3				Hypo 4			
Trees Treatment lb/ac.	.5	1	2	C	.5	1	2	C	0.5	1	2	C	0.5	1	2	C
Abies grandis	X															
Abies lasiocarpa	X		X		X	X		X		X	X		X		X	
Larix occidentalis		X		X	X	X	X	X					X		X	
Pinus contorta									X	X	X	X				
Pinus monticola	X		X		X	X	X	X	X	X	X	X	X	X	X	X
Pinus ponderosa																
Picea engelmannii				X					X	X	X	X	X		X	X
Populus tremuloides																
Pseudotsuga menziesii	X		X	X	X		X		X	X	X	X		X	X	X
Thuja plicata																
Tsuga heterophylla																
Tsuga mertensiana								X	X	X				X	X	
Shrubs																
Acer glabrum																
Alnus sinuata	X	X				X										
Amelanchier alnifolia																
Arctosaphylos uva-ursi																
Berberis repens																
Ceanothus velutinus		X												X	X	X
Chimaphila umbellata													X			X
Ledum glandulosum		X	X	X												
Linnaea borealis																
Lonicera utahensis	X	X	X	X		X			X		X	X	X	X		
Menziesia ferruginea					X	X		X	X	X	X	X	X	X	X	X
Pachistima myrsinites	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ribes aureum																
Ribes cereum																
Ribes viscosissimum																
Rosa gymnocarpa (complex)																
Rubus parviflorus	X															
Salix bebbiana																
Salix scoulerian						X	X		X	X	X	X		X	X	
Sambucus coeulea																
Shepherdia canadensis																
Sorbus sitchensis			X	X		X	X	X				X	X			X
Spiraea betulifolia																
Vaccinium globulare	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Vaccinium scoparium																
Symphoricarpos albus																
Herbs																
Achillea millefolium																
Adenocaulon bicolor				X					X	X	X	X				
Anaphalis margaritacea		X		X												
Antennaria racemosa																
Arnica cordifolia																
Chimaphila umbellata																
Cirsium canadensis																
Clintonia uniflora																
Cynoglossum boreale																

	Hypo 1				Hypo 2				Hypo 3				Hypo 4			
Herbs & Horsetails	0.5	1	2	C	0.5	1	2	C	0.5	1	2	C	.5	1	2	C
Disporum trachycarpum																
Epilobium angustifolium														X		X
Equisetum arvense																
Fragaria vesca																
Fragaria virginiana																
Gallium boreale																
Gallium trifolorum																
Goodyeara oblongifolia																
Hieracium sp.																
Lupinus sericeus																
Pyrola asarifolia									X			X	X			
Pyrola picta																
Pyrola secunda																
Pyrola uniflora																
Solidago occidentalis																
Smilacina racemosa																
Smilacina stellata																
Thalictrum occidentale																
Tiarella unifoliata																
Trifolium agaricum																
Vicia sp.																
Viola orbiculata																
Viola nuttallii																
Xerophyllum tenax	X			X	X	X	X	X	X							
Verbascum thapsus																
Erythronium grandiflorum																
Mint unk.																
Grasses, Sedges																
Calamagrostis rubescens																
Carex geyeri	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Carex concinnoides																
Elymus virginicus																
Festucca occidentalis																
Phleum pratense																
Unknown Grass																
Unknown Tall Grass																
Other																
Polytrichum sp.																
Other moss	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bracken																
Gray thallose lichen																
Fern																
Hairy																
Unknown Composite																
Epilobium latifolium																

Fall Treatments

	Miller Ck 5				Miller Ck. 6				Lubrecht 7				Lubrecht 8				Orr, MT 9			
	1	2	3	C	1	2	3	C	1	2	3	C	1	2	3	C	1	2	3	C
ABGR	X																			
ABLA	X	X	X	X		X	X													
LAOC		X	X		X	X	X	X	X			X		X	X	X				
PICO																		X		X
PIMO			X	X																
PIPO	X			X						X			X	X	X					
PIEN	X	X	X	X	X	X	X	X									X		X	X
POTR					X								X							
PSME		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
THPL	X	X	X	X																
TSHE																	X	X	X	X
TSME	X	X	X	X																
Shrubs																				
ACGL		X			X	X	X	X												
ALSI	X	X	X	X				X					X			X	X	X	X	X
AMAL					X						X	X	X		X	X				
ARUV									X	X	X	X	X	X	X	X				
BERE					X	X	X		X		X			X	X					
CEVE																	X	X	X	X
CHUM	X	X	X	X	X	X	X	X	X	X	X	X	X		X					
LEGL																				
LIBO						X	X	X	X	X	X	X	X	X	X	X				
LOUT	X		X	X		X					X	X	X			X				
MEFE	X	X		X	X	X	X	X		X	X		X			X		X	X	X
PAMY																	X	X	X	X
RIAU	X	X	X	X																
RICE					X	X	X	X									X		X	X
RIVI		X	X																	
ROGY						X	X	X	X	X	X	X	X	X	X	X				X
RUPA	X	X	X	X	X	X	X	X									X	X	X	X
SABE	X	X		X						X			X	X		X				
SASC		X	X	X	X	X		X	X	X	X	X	X	X	X	X				
SACO																				
SHCA		X			X	X	X		X	X		X		X	X					
SOSI																			X	X
SPBE		X			X	X	X	X	X	X	X	X					X	X	X	X
VAGL	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VASC																				
SYAL									X		X	X								
Herbs																				
ACMI									X			X	X	X	X	X				
ADBI	X	X	X	X																X
ANMA	X	X	X	X													X	X	X	X
ANRA					X				X			X	X	X		X				
ARCO	X	X	X	X					X	X	X		X			X	X	X	X	X
CHUM																				
CICA																				
CLUN	X	X	X	X													X	X	X	X
CYBO																				

Fall Treatments

	Miller Ck. 5				Miller Ck. 6				Lubrecht 7				Lubrecht 8				Orr MT. 9			
	1	2	3	C	1	2	3	C	1	2	3	C	1	2	3	C	1	2	3	C
DITR			X	X																
EPAN	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X
EQAR				X																
FRVE																				
FRVI											X		X			X				
GABO	X	X	X	X					X			X						X		X
GATR	X	X	X	X				X												
GOOB					X	X	X	X												
HI sp						X		X									X			X
LUSA																				
PYAS		X	X						X		X	X		X	X	X				
PYPT					X	X	X	X					X			X	X	X	X	X
PYSE					X	X	X	X	X	X	X	X	X	X	X	X				
PYUN	X	X	X	X																
SOOC	X	X	X	X													X		X	
SMRA	X	X	X	X												X	X	X	X	X
SMST	X	X	X	X																
THOC		X				X	X	X			X	X		X			X	X	X	X
TION																	X	X	X	X
TRAG									X											X
VI sp.									X	X	X	X								
VIOB	X	X	X	X													X	X	X	X
VINU																				
XETE					X	X	X	X												
VETH													X							
FRGR															X					
Mint																				
CARU					X	X	X	X	X	X	X	X	X	X	X	X				
CAGE									X	X	X	X	X	X	X	X	X	X	X	X
CACO									X	X	X	X	X	X	X	X	X			X
ELVI									X	X		X				X				
FEOC											X									
PHPR								X												
Unk. Gr.							X	X												
Unk. T. Gr.																				
PO sp.																				
Moss	X	X	X	X	X	X	X	X									X	X	X	X
Bracken					X	X	X	X	X	X	X	X	X	X	X	X				
Gray				X													X	X	X	X
Fern					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unk.	X	X	X	X																
Comp.					X															
EPLA									X	X	X	X								

	Gov. Mt 10				Edith Pk 11				Edith Pk 12			
	1	2	3	C	1	2	3	C	1	2	3	C
ABGR			X									
ABLA	X	X	X	X								X
LAOC					X	X	X		X	X	X	X
PICO												
PI MO				X								
PIPO												
PIEN	X	X	X	X								
POTR												
PSME					X	X	X	X		X	X	X
THPL												
TSHE	X	X	X	X								
TSME												
Shrubs												
ACGL												
ALSI				X								
AMAL												
ARUV												
BERE												
CEVE												
SHUM			X		X	X	X		X	X	X	X
LEGL												
LIBO												
LOUT	X											
MEFE	X	X	X	X								
PAMY	X	X	X	X	X							
RIAU												
RICE												
RIVI		X		X								
ROGY												
RUPA												
SABE			X									
SASC	X	X	X	X								
SACO	X	X		X								
SHCA												
SOSI			X									
SPBE					X	X	X	X	X	X	X	X
VAGL	X	X	X	X	X	X	X	X	X	X	X	X
VASC					X	X	X	X	X	X	X	X
SYAL												
Herbs												
ACMI												
ADBI												
ANMA								X		X	X	
ANRA												
ARCO	X	X	X	X								
CHUM												
CICA								X			X	X
CLUN												
CYBO					X							

Fall Treatment

	Gov. MT 10				Edith Pk. 11				Edith Pk. 12			
	1	2	3	C	1	2	3	C	1	2	3	C
DITR												
EPAN					X	X	X	X	X	X	X	X
EQAR												
FRVE												
FRVI												
GABO												
GATR												
GOOB		X	X									
HI sp								X	X	X	X	
LUSA					X	X	X	X	X	X	X-?	
PYAS												
PYPT	X	X	X	X								
PYSE	X	X	X	X								
PYUN												
SOOC												
SMRA												
SMST												
THOC												
TION												
TRAG												
VI sp.												
VIOB												
VINU	X		X	X	X	X	X	X		X	X	X
XETE												
VETH	X	X	X	X	X	X	X	X	X	X	X	X
FRGR												
Mint												
CARU												X
CAGE												
CACO		X		X	X				X		X	X
ELVI					X	X	X	X-?				
FEOC		X			X	X	X	X				
PHPR												
Unk. Gr.												
Unk. T. Gr.												
PO sp.												
Moss											X	
Bracken												
Gray												
Fern	X	X	X	X	X	X	X	X	X	X	X	X
Unk.	X	X		X								
Comp.												
EPLA									X		X	X